

WHAT IS CLAIMED IS:

1. An oxygen concentration detection system having an oxygen sensor comprising a sensor element including a combination of an oxygen pump cell and an oxygen-partial-pressure detection cell; a control circuit connected to the sensor element via wiring lines adapted to control the oxygen pump cell such that the output voltage of the oxygen-partial-pressure detection cell is maintained at a predetermined value, the oxygen sensor detecting the concentration of oxygen contained in a gas to be measured having an oxygen concentration within a predetermined range, and the oxygen concentration detection system outputting measurement signals of a plurality of types, including a first signal corresponding to a magnitude of current flowing through the oxygen pump cell, a second signal corresponding to an electric potential of the oxygen-partial-pressure detection cell, and a third signal corresponding to a resistance of the oxygen-partial-pressure detection cell, the oxygen concentration detection system comprising:

anomaly detection means for detecting a sensor anomaly by determining whether at least one of respective levels of signals which represent electric potentials at different portions of the sensor element, the wiring lines, and the control circuit falls within a predetermined range;

modification means for issuing a first instruction when the anomaly detection means does not detect an anomaly, the first instruction indicating non-detection of an anomaly, and for issuing a second instruction when the anomaly detection means detects a sensor anomaly, the second instruction corresponding to the detected anomaly; and

output means for through-outputting the measurement signals when the modification means outputs the first instruction signal and for outputting a selected

measurement signal modified to have a level outside the corresponding range within which the level of the selected measurement signal varies in a normal state.

2. The oxygen concentration detection system as claimed in claim 1, wherein the anomaly detection means detects an anomaly of at least one of the oxygen pump cell, the oxygen-partial-pressure detection cell, the control circuit, and the wiring lines.

3. The oxygen concentration detection system as claimed in claim 1, wherein both a measurement signal in a normal state and measurement signal modified to have a level falling outside the predetermined range are output through the same signal line.

4. The oxygen concentration detection system as claimed in claim 1, wherein the output means includes (i) switches for switching their connection states in accordance with an instruction from the modification means and (ii) a constant voltage power source, wherein when the second instruction indicative of an anomaly is output from the modification means, the constant voltage power source is connected, through a switching operation of the switches, to a signal line to which a selected one of the measurement signals is output, to thereby change the level of the selected measurement signal to a level falling outside the predetermined range within which the level of the measurement signal varies in a normal state.

5. The oxygen concentration detection system as claimed in claim 1, wherein

when a sensor anomaly occurs,

the anomaly detection means determines that the level of one of the signals which represent electric potentials at different portions of the sensor element, the wiring lines, and the control circuit falls outside the corresponding predetermined

range, and outputs a predetermined anomaly detection signal in accordance with the type and level of the signal whose level falls outside the predetermined range;

the modification means issues, in accordance with the anomaly detection signal output from the anomaly detection means, a control signal for specifying a signal which is to be output at a level falling outside the corresponding range within which the level of the signal varies in a normal state; and

the output means outputs, on the basis of the control signal output from the modification means, at least one of the measurement signals specified by the modification means, at a predetermined level falling outside the corresponding range within which the level of the signal varies in a normal state, whereby the location and/or state of the anomaly of the sensor element is reported.

6. The oxygen concentration detection system as claimed in claim 1, wherein the anomaly detection means, the modification means, and the output means are provided in the control circuit of the sensor element.

7. The oxygen concentration detection system as claimed in claim 1, wherein the oxygen sensor includes a heater for heating the sensor element; and a heater control circuit for controlling electric power supplied to the heater such that the sensor element is maintained at a predetermined temperature.

8. The oxygen concentration detection system as claimed in claim 1, wherein when an anomaly is detected in the signals representing the electric potentials at the different locations, the output means changes the level of a measurement signal corresponding to the resistance of the oxygen-partial-pressure detection cell to a level falling outside the predetermined range in which the level of the measurement signal varies in a normal state.

9. A vehicle control system comprising:

an oxygen sensor comprising a sensor element including a combination of an oxygen pump cell and an oxygen-partial-pressure detection cell; a control circuit connected to the sensor element via wiring lines and adapted to control the oxygen pump cell such that the output voltage of the oxygen-partial-pressure detection cell is maintained at a predetermined value, the oxygen sensor detecting concentration of oxygen contained in a gas to be measured having an oxygen concentration within a predetermined range;

anomaly detection means for detecting a sensor anomaly by determining whether or not at least one of respective levels of signals which represent electric potentials at different portions of the sensor element, the wiring lines, and the control circuit falls within a predetermined range;

modification means for issuing a first instruction when the anomaly detection means does not detect an anomaly, the first instruction indicating non-detection of an anomaly, and for issuing a second instruction when the anomaly detection means detects a sensor anomaly, the second instruction corresponding to the detected anomaly;

output means for through-outputting the measurement signals when the modification means outputs the first instruction signal and for outputting at least a selected one of the measurement signals when the modification means outputs the second instruction signal, the selected measurement signal being modified to have a level outside the corresponding range within which the level of the selected measurement signal varies in a normal state; and

anomaly judgment means for judging whether or not the vehicle control system is anomalous, on the basis of measurement signals of a plurality of types, including a first signal corresponding to a magnitude of current flowing through the

oxygen pump cell, a second signal corresponding to an electric potential of the oxygen-partial-pressure detection cell, and a third signal corresponding to a resistance of the oxygen-partial-pressure detection cell.

10. The vehicle control system as claimed in claim 9, wherein the anomalous judgment means stores a relationship between levels of the measurement signals and type and locations of anomalies; and the anomalous judgment means determines the type and location of an anomaly of a sensor on the basis of levels of the measurement signals and the stored relationship.

11. The vehicle control system as claimed in claim 9, wherein the anomaly detection means detects an anomaly of at least one of the oxygen pump cell, the oxygen-partial-pressure detection cell, the control circuit, and the wiring lines; and the anomaly judgment means judges an anomaly of the sensor on the basis of the levels of the measurement signals.

12. A vehicle control system, comprising:

an oxygen sensor comprising a sensor element including a combination of an oxygen pump cell and an oxygen-partial-pressure detection cell; a control circuit connected to the sensor element via wiring lines and adapted to control the oxygen pump cell such that the output voltage of the oxygen-partial-pressure detection cell is maintained at a predetermined value, the oxygen sensor detecting the concentration of oxygen contained in a gas to be measured having an oxygen concentration within a predetermined range;

storage means for storing a relationship between types and locations of anomalies and levels of measurement signals of a plurality of types, including a first signal corresponding to a magnitude of current flowing through the oxygen pump cell, a second signal corresponding to an electric potential of the oxygen-partial-pressure

detection cell, and a third signal corresponding to a resistance of the oxygen-partial-pressure detection cell; and

anomaly judgment means for determining a type and/or location of an anomaly of the sensor, based on levels of the measurement signals and the stored relationship, when the air fuel ratio of an engine is controlled to a lean side and the second signal corresponding to the electric potential of the oxygen-partial-pressure detection cell is equal to or lower than a predetermined voltage.

13. The vehicle control system as claimed in claim 12, wherein the location and/or state of an anomaly of the vehicle control system is determined on the basis of the output level of the third signal corresponding to the resistance of the oxygen-partial-pressure detection cell.

14. A vehicle control system as claimed in claim 12, wherein the operation of performing an anomaly judgment when the air fuel ratio of the engine is controlled to the lean side causes the anomaly judgment means to perform an anomaly judgment on the basis of the levels of the measurement signals when the oxygen sensor is exposed to ambient atmosphere.

15. An oxygen concentration detection system, comprising an oxygen sensor having a sensor element with a heater for heating the sensor element; a sensor control circuit for controlling the sensor; an anomaly detection means for detecting an anomaly of the sensor when at least one of measurement signals at the sensor control circuit has an electric potential falling outside a predetermined range; a modification or switching means for issuing a first instruction when the anomaly detection means does not detect an anomaly, the first instruction indicating non-detection of an anomaly, and for issuing a second instruction when the anomaly detection means detects a sensor anomaly, the second instruction corresponding to the detected

anomaly; and output means for through-outputting a corresponding measurement signal when the modification or switching means outputs the first instruction signal and for outputting at least a selected one of the measurement signals when the modification or switching means outputs the second instruction signals, the selected measurement signal being modified or switched to have a level outside the corresponding range within which the level of the selected measurement signal varies in a normal state.

16. The oxygen concentration detection system as claimed in claim 15, further comprising judgment means for judging an anomaly of the oxygen concentration system based on a plurality of measurement signals of the sensor.

17. The oxygen concentration detection system as claimed in claim 15, further comprising memory means for storing data on kinds and locations of anomalies of the oxygen concentration detection system so that the oxygen concentration detection system makes anomaly judgments based on a plurality of the measurement signals and the stored data.